Correlation of Head Trauma and Traumatic Aneurysms

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Key words: trauma, skull, fracture, aneurysm, endovascular treatment

Summary

Subarachnoid hemorrhage following severe trauma to the head is relatively common. In most cases the bleed originates from superficial veins and occasionally from arteries. Following the replacement of cerebral angiography with CT in the diagnostic evaluation of head traumas fewer traumatic aneurysms have been observed. This may indicate that some traumatic aneurysms are missed if angiographic procedures are not performed in patients with severe head injury.

Trauma patients admitted to our institution are submitted to CT including a bone algorithm. In case of subarachnoid hemorrhage, especially in the basal cisterns, CT- angiography is performed. Digital subtraction angiography is performed as well in cases with uncertain interpretations.

During one year 81 patients were admitted with subarachnoid hemorrhage following head trauma. Thirteen (16%) of them underwent CT-angiography and in five (6.2%) with SAH in the basal cistern traumatic aneurysms were found. Four of these cases had a skull base fracture including fractures through the clivus. Four cases were embolized and one very small extradural aneurysm is still not treated. One small pericallosal aneurysm was operated.

A traumatic aneurysm should always be suspected n patients with skull base fractures and subarachnoid hemorrhage in the basal cisterns.

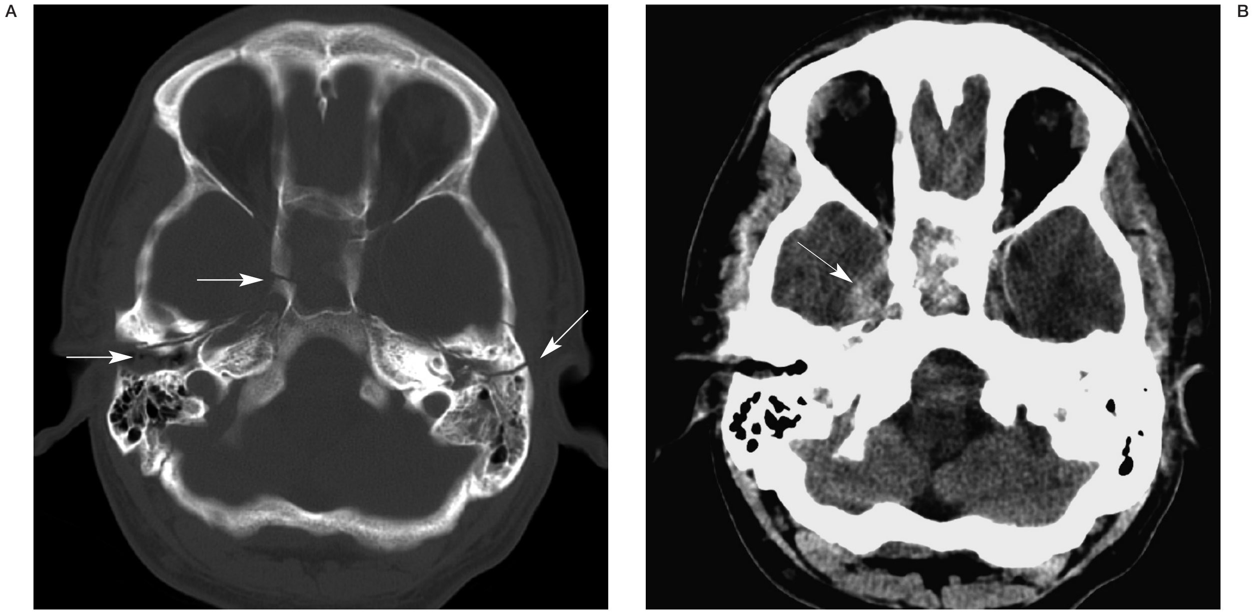
Introduction

Posttraumatic subarachnoid hemorrhage (SAH) is relatively frequent in serious head traumas, up to 20% in our institution. Small amounts of blood in the sulci of the convexities is the most common finding and are probably caused by bleeding from small superficial veins rather than arteries [3,4]. Frequently intracerebral hematomas and brain lesions occur in the same area as the SAH.

Bleeding from cerebral traumatic aneurysm formation occurs in approximately 1% of all cases with subarachnoid hemorrhage from aneurysms in adults [1,2]. SAH in children is always suspect of traumatic aneurysm since spontaneous aneurysms are very rare in children.

Traumatic aneurysms may be separated into three types. False aneurysms (pseudoaneurysms) have no wall components and are formed by the surrounding anatomic structures and in some cases also by a hematoma around the ruptured arterial wall [3]. Bleeding from such aneurysms appears immediately following the trauma. The aneurysm cavity tends to increase quickly in size. The risk of a second bleeding is extremely high and may occur after resorption of surrounding edema and hematoma.

The second type, true false aneurysm, is formed when not all layers of the arterial wall are disrupted; e.g. with a remaining adventitia and basal membrane [2,3]. These aneurysms may have primary bleeding due to partly rupture of



all wall components followed by quick repair. Early follow-up studies may show slow growth which is a sign of threatening re-rupture A third type is the dissecting aneurysm, that is a false lumen between the intimal and elastic layers. These aneurysms may occlude spontaneously or lead to closure of the artery or bleed.

A mixture of all types of traumatic aneurysms may even occasionally be seen.

In SAH located in the basal cisterns it might be difficult to know whether the bleeding preceded the trauma or if the bleeding resulted from a traumatic damage to the arteries. However, a bleeding in the basal cistern should in any case be subject to further neuroradiological examination to find the source of bleeding [5,6].

The aim of this paper is to describe the diagnostic and therapeutic aspects in patients with skull base fractures and traumatic cerebral aneurysms.

Material and Methods

From May 2006 to June 2007, 81 patients with traumatic SAH after head trauma were admitted and diagnosed from computed tomography (CT). The distribution of blood and additional clinical and radiological findings gave no indication of an aneurysmal development in 68 cases (84%)

The conclusion based on medical history and CT findings seemed uncertain in 13 patients (16%) and a traumatic aneurysm could not be excluded. All 13 underwent CT-angiography (CTA) and digital subtraction angiography (DSA) was added in six patients.

Results

Aneurysm was found in five (6.2%) out of 81 patients admitted with traumatic SAH and all had a skull base fracture as well. Blood was restricted to the basal cisterns close to the fracture in these patients. One aneurysm was located on the superior cerebellar artery. Four aneurysms were located on the carotid arteries, three extradurally (figure 1A-F) and one other intradurally. One originated from the superior cerebellar artery. Two of the extradurally located aneurysms were probably dissecting aneurysms. The SAH was extensive in the basal cisterns as well as in the anterior interhemispheric fissure in one child and an aneurysm arising from the left pericallosal artery was found (figure 2A-E).

Unlike spontaneous aneurysms all five traumatic aneurysms arose outside the arterial bifurcations. All aneurysms were embolized except the pericallosal aneurysm that underwent surgical occlusion. Table 1 gives an overview of the five cases.

The explanation for the sparse SAH in the extradural aneurysms may be the dissecting nature of the damage to the carotid arteries and rupture of the dura along the arteries.

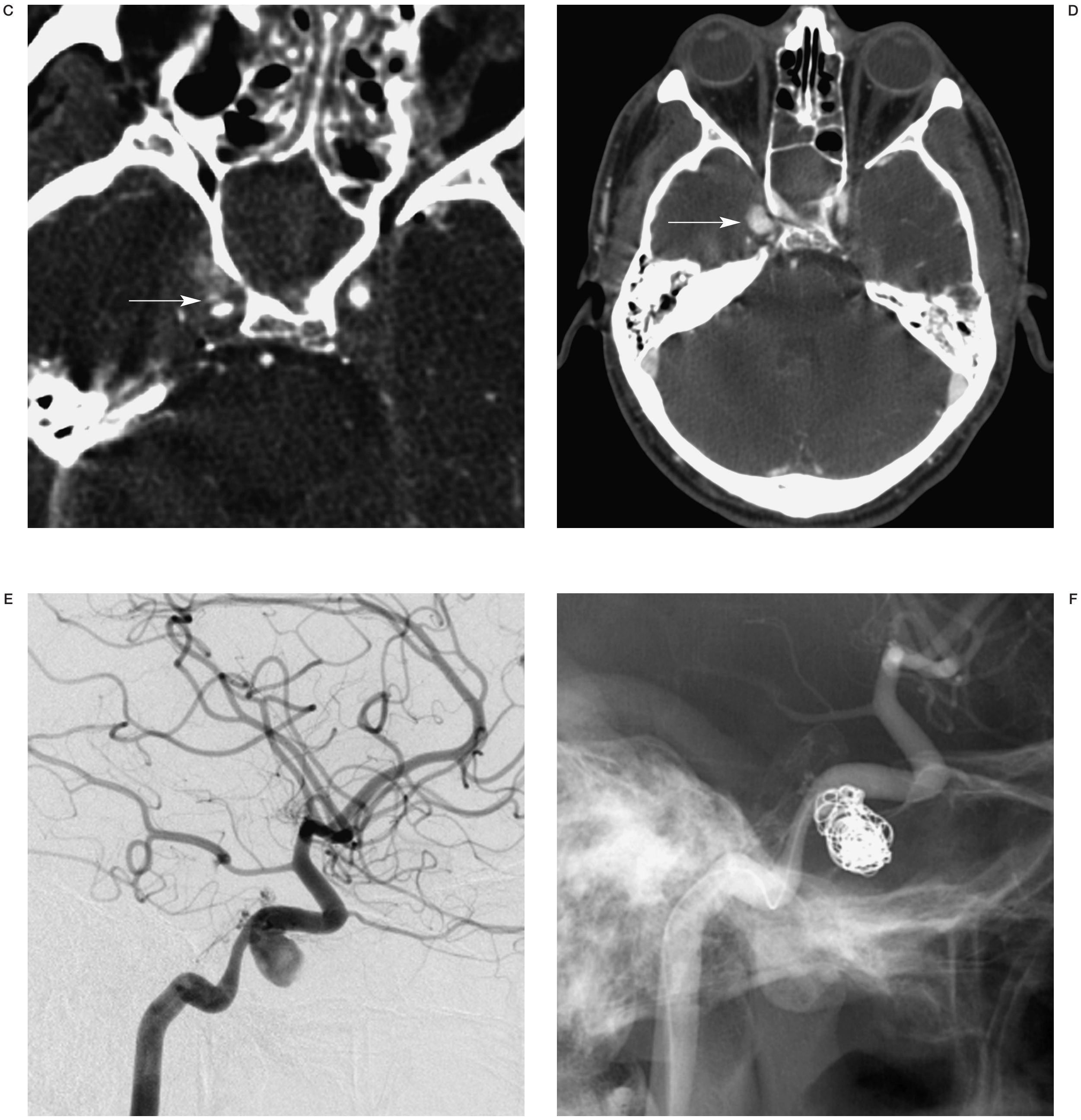


Figure 1 A 30-year-old man involved in a traffic accident. A) Skull base fracture involving the sphenoid bone (arrows). B) CT shows discrete SAH in the right parasellar region (arrow). C) CTA, axial cut through cavernous sinus, demonstrates a small leakage from the carotid artery into the cavernous sinus (CCF). D) CTA after two days demonstrates aneurysm in the same location (arrow). E,F) DSA before and after coiling.

The young girl with the pericallosal aneurysm was awake and in good clinical condition throughout her stay. All other patients had long intensive care but survived with minor deficits. Control angiographies showed patent occlusion of the embolized aneuryms.

Discussion

Not unlike the experience of others we have seen fewer reports of traumatic aneurysms in connection with severe head traumas following the introduction of CT as the primary radiological tool in head traumas. In the late 70`s and early 80`s when cerebral angiography was still an important tool in diagnosing the nature of damage to the brain, traumatic aneurysm seemed to be more frequently reported [7,8, 9,10,11]. In later years reports have been more sporadic [12,13]. Our institution covers a population of 2.5 million people and the low incidence of aneurysms diagnosed after severe traumas during the last couple of decades led us to believe that many traumatic aneurysms were left undiagnosed. That might be very unfortunate since the mortality and morbidity of such aneurysms is considered to be high [3,4,5].

During recent years modern CT has given us the possibilities of producing detailed CTA. All spontaneous subarachnoid hemorrhages are examined with CTA on admission [14]. These examinations are the basis for further diagnostic steps, as they also are in patients with suspected traumatic aneurysms and arterial dissections [15]. Young individuals seem to be especially at risk of developing traumatic aneurysms and it seems appropriate to draw special attention to children with massive SAH and hematomas around the anterior cerebral falx. When the brain is dislocated laterally crossing the midline and anterior falx the anterior cerebral arteries are at risk of wall damage and aneurysm development [2,6]. Even newborns may develop an aneurysm following traumatic births [16].

Due to our increased awareness we have disclosed more traumatic aneurysms in the last year than ever before. We therefore deem it appropriate to remind everyone who is involved in treating severe head trauma of this definitive possibility. We point out that almost all traumatic aneurysms in our material have a skull base fracture which seems to be the cause of the arterial damage and aneurysm development. All trauma centers today have the environment to perform CTA and thus should disclose this dangerous clinical condition before it is too late. CTA is an easy examination to perform and it seems easy to defend a clinical routine that produces some CTAs too many rather than risk overlooking a traumatic aneurysm. SAH in children should be a definitive indication of a traumatic aneurysm since spontaneous aneurysms almost never occur in children [17] even if the trauma is considered to be minor [18]. Increasing numbers of gunshot and penetration traumas from sharp objects give an additional cause for more traumatic cerebral aneurysms [19,20,21].

Since the rate of lethal rebleed is around 50% in some traumatic aneurysms [2,5] an early treatment strategy is important. The treatment options vary between surgery and neuroradiological intervention and the treatment should consequently be located to larger trauma centres with acute neurosurgical and neuroradiological services.

Carotid cavernous fistula (CCF) is another related condition that may develop from skull base fracture following arterial rupture of carotid arteries in the region of the cavernous sinus [22,23]. CCF is usually easy to disclose since retrograde arterial flow in the ophthalmic vein usually gives a red pulsating eye.

In some patients the medical history makes it very difficult to define whether the aneurysm is spontaneous or of traumatic origin [24]. The clue to this diagnostic problem may be the skull base fractures and other brain injuries. In some cases the aneurysm formation may be very sub-

Table 1 **Summary of diagnostic and treatment data.**
Cerebral parenchymal damage; grades 0 = none, 1 = slight, 2 = moderate, 3 = severe.

Case No.	SAH (Fischer grade)	Cerebral damage	Skull base fracture	Coiled	Operated	Rebleed
1	3	+++	yes	yes	no	no
2	1	+	yes	yes	no	no
3	2	++	yes	yes	no	no
4	2	++	yes	no	no	no
5	2	o	no	no	yes	no
total		4	4	3	1	0

Figure 2 Bicycle accident in a 12-year-old girl. A,B) CT shows blood in the basal cisterns and in the frontal interhemispheric fissure (arrow). C) CTA demonstrates a small aneurysmal formation on the left anterior cerebral artery (arrow). DSA five days following the trauma shows a slightly increased size. E) Preoperative MR-angiography demonstrates an even larger growing aneurysm (arrow).

tle and develop slowly as in our case with the young girl [25]. Considering the excellent tools for CT-angiography and the low complication rate, the threshold for repeat angiography should be low. In some rare cases spontaneous occlusion of traumatic aneurysms may be observed [26].

Conclusions

Traumatic SAH is relatively frequent in severe head trauma. Most cases have no arterial damage or aneurysmal development. However, it is important to draw special attention to cases with skull base fractures and SAH in the basal cisterns. We found traumatic aneurysms in 6.2% of cases with severe head trauma and SAH. It is important to treat these aneurysms since the risk of re-hemorrhage is assumed to be high. Aneurysms in children must be considered likely to be of traumatic origin even in minor traumas. In unclear cases with posttraumatic SAH repeat angiography should probably be performed; at least CT angiography.

Endovascular coiling of traumatic aneurysms has proved to be a safe and adequate treatment.

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